E-D7

Graduate Education Curriculum on the Semantic Web - a first draft

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Abstract

This document presents a proposal for structuring the body of knowledge in the field of Semantic Web to be used as a draft recommendation for a graduate curriculum. The structure emerged from the analysis of existing courses and from discussions within REWERSE and within Knowledge Web. Also, the document shows how the proposed structure is covered by learning materials uploaded in REASE (with indication of the contributions by REWERSE members) and by the Semantic Web courses offered in the European Master Program in Computational Logic. A concrete plan for forthcoming REWERSE activities is presented, which identifies the topics in the structure for which new learning materials are to be developed by REWERSE members.

Keyword List

semantic web, education and training

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Graduate Education Curriculum on the Semantic Web - a first draft

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This document presents a proposal for structuring the body of knowledge in the field of Semantic Web to be used as a draft recommendation for a graduate curriculum. The structure emerged from the analysis of existing courses and from discussions within REWERSE and within Knowledge Web. Also, the document shows how the proposed structure is covered by learning materials uploaded in REASE (with indication of the contributions by REWERSE members) and by the Semantic Web courses offered in the European Master Program in Computational Logic. A concrete plan for forthcoming REWERSE activities is presented, which identifies the topics in the structure for which new learning materials are to be developed by REWERSE members.

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Contents

1 Introduction

This deliverable presents a draft proposal for structuring the body of knowledge in the field of the Semantic Web. Understanding of the structure of this rapidly developing field is essential for providing recommendations for higher education curricula on M.Sc. and Ph.D levels, as well as for industrial courses and for supporting Semantic Web education with learning materials. An important aspect of the structuring effort is the identification of relations between the Semantic Web and the existing body of knowledge in Computer Science.

The present version of the proposed structure builds upon the previous work documented in the following deliverables:

- Deliverable E-D1 presented information on already offered university courses relevant for the Semantic Web.

- Analysis of the information in E-D1 resulted in a preliminary structure presented in E-D5, which was the subject of a discussion initiated by Hannover and involving members of Knowledge Web. The result of this discussion is a refined draft structure at

  https://wiki-sop.inria.fr/wiki/bin/view/Acacia/KnowledgeWeb

  Its modified version is used in the joint Knowledge Web and REWERSE educational infrastructure REASE[1] (see E-D6) for classification of learning materials. This structure is quoted in Appendix A together with references to learning resources and courses surveyed in this document.

This deliverable shows also how the proposed structure can be used for classification of the Semantic Web relevant courses offered in the ERASMUS MUNDUS supported European Master Program in Computational Logic. In this program all students get solid background in Computational Logic, essential for Semantic Web research, and are also offered specific courses in the field of the Semantic Web. It should be noticed that the universities participating in this program are also involved in REWERSE or in Knowledge Web. More detailed information about the content of the learning units offered in the program is provided in Appendix B.

This document:

- presents a rationale for the proposed structure,

- indicates its links to IEEE/ACM Computer Science Curriculum CC2001 with the objective to identify the prerequisites covered by undergraduate CS learning units described in CC2001,

- analyses coverage of the topics in the presented structure by the REASE learning material provided by REWERSE members and by the courses offered in the ERASMUS MUNDUS supported European Master Program in Computational Logic,

- outlines necessary steps in continuation of this work.

[1] `http://rease.semanticweb.org`

2 Structuring of the Semantic Web body of knowledge

2.1 Objectives

The long range objective of the work is to develop recommendations for structure and options of graduate Semantic Web education. As pointed out in E-D5 the main target groups are

- University teachers,
- M.Sc and Ph.D students.

The recommendations should clearly identify:

- prerequisites for graduate Semantic Web education, indicating topics from undergraduate Computer Science education,
- advanced foundational topics, usually not covered on undergraduate level,
- core topics in Semantic Web education,
- special topics.

2.2 Specifying Prerequisites

Different options of graduate Semantic Web education may require different background knowledge. Options are not discussed in this deliverable and will be addressed in continuation of this work. This section attempts to identify prerequisites which may be needed in some options but not necessarily in all of them.

We take IEEE/ACM CC2001 as standard reference to undergraduate curricula in Computer Science. We refer to the areas and units specified therein, using the terminology and the unit codes of CC2001.

As a general guidance for the identification of prerequisites for graduate Semantic Web education we take the introductory sentence at the main page of W3C Semantic Web Activity (http://www.w3.org/2001):

"The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries."

and quoted therein the statement by Tim Berners-Lee, James Hendler and Ora Lassila:

"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation".

Thus the prerequisites for Semantic Web education should include topics in the following areas of the CS Body of Knowledge as defined in CC2001:

- *Information Management (IM)*, addressing the issues of:
  - organization, transformation and presentation of information,
  - data modelling and abstraction,
  - security, privacy and protection in a shared environment,
  - data mining;
- *Intelligent Systems (IS)*, addressing the issues of:

  - knowledge representation and reasoning,
  - agents,
  - natural language processing;

- *Net-Centric Computing (NC)*, addressing the issues of:
  - Web standards and technologies,
  - Network security,
  - Distributed systems.

2.2.1 Information Management (IM)

The following IM topics, as specified in CC2001, seem to be relevant in Semantic Web education

IM1 Information models and systems,

IM2 Database systems,

IM3 Data modeling, including conceptual models (entity-relationship and UML), relational data models, object-oriented models and semistructured data,

IM5 Database query languages.

Generally the field of Information Management is very broad and its structuring in CC2001 may not be fully adequate for purposes of Semantic Web education. However, some topics like conceptual modelling or semistructured data are of direct importance for Semantic Web education.

2.2.2 Intelligent Systems (IS)

The following IS topics, as specified in CC2001, are of particular importance

IS3 Knowledge representation and reasoning (including review of propositional and predicate logic, resolution and theorem proving),

IS5 Advanced knowledge representation and reasoning (with focus on description logics, on nonmonotonic reasoning and on reasoning on action and change),

IS6 Agents,

IS7 Natural language processing.

Courses on Knowledge Representation and Reasoning, Agents, and Natural Language processing offered in undergraduate curricula may not be sufficient for graduate Semantic Web education. In particular, we note that, due to an unfortunate decision, CC2001 does not include logic programming thus neglecting its importance in Knowledge Representation and Reasoning. These topics are very relevant for graduate Semantic Web education, among others as a prerequisite for studying rules on the Semantic Web. Thus a graduate Semantic Web program should offer specialized advanced courses on relevant topics not covered by undergraduate curricula.

2.2.3 Net-centric Computing (NC)

The following NC topics, as specified in CC2001 are relevant as prerequisites for Semantic Web education:

NC1 Introduction to net-centric computing,

NC2 Communication and networking,

NC3 Network security,

NC5 Building web applications.

2.3 Other Foundational Topics

The above listed CC2001 topics in undergraduate education give a general background for Semantic Web education. Some of them may need additional advanced courses. Also some of advanced foundational topics relevant for the Semantic Web are not covered by CC2001. The following list of foundational topics, reflecting previous discussions in REWERSE and in Knowledge Web, includes foundational topics from both categories mentioned above:

- Knowledge Engineering and Ontology Engineering
  - Methodologies,
  - Ontology population/generation,
  - Maintenance and versioning (dynamics),
  - Mapping/translation/matching/aligning (heterogeneity),
  - Validation,
  - Interoperability/Integration,
  - Modularization and Composition,
  - Tools;
- Web information technologies
  - XML (including Namespaces, Schema Languages, XML query and transformation languages, XML programming techniques),
  - Web data integration,
  - Security,
  - Web services,
  - Personalization techniques,
  - Web data extraction/information extraction,
  - Architecture of Web Information Systems.

Notice that the above topics do not address explicitly the Semantic Web. However, development of the Semantic Web relies to large extent on the use of ontologies and on the use of the above listed web technologies.

2.4 Semantic Web: Core Topics

The emerging structure of the core topics presented below summarizes previous discussions. It reflects to some extent the W3C vision of the Semantic Web layers, with emphasis on the already existing layers. It is complemented by topics providing general perspective on the architecture of the Semantic Web and on Semantic Web Services. The issue of Semantic Web querying and updates, present on all layers of the Semantic Web is formulated as a separate topic. An attempt is also made to provide a draft classification of emerging Semantic Web applications. The suggested structure is as follows:

- Resource Description Framework (RDF) and RDF Schema
- Ontology layer of the Semantic Web
  - Ontology representation/Ontology languages/OWL,
  - Semantic Web Ontology Engineering,
  - Ontology reasoners;
- Rule and logic layer of the Semantic Web
  - Rule languages/ rule Markup,
  - Integration of rules and ontologies,
  - Rule reasoners, actuators and reactors,
- Semantic Web query and update languages
- Security/trust/privacy in the Semantic Web
- Semantic Web Applications
  - Knowledge Management,
  - e-learning,
  - Bioinformatics,
  - Multimedia,
  - e-health,
  - e-business,
  - Law,
  - Engineering,
  - e-government.

2.5 Semantic Web: Special Topics

The topics listed below, also originating from the previous discussion, address special aspects of the Semantic Web. They reflect issues discussed in existing Semantic Web courses and in research. Most of them concern interdisciplinary efforts of integrating ongoing research into the Semantic Web:

- Natural language processing/ human language technologies in the Semantic Web,
- Social impact of the Semantic Web,
- Social networks and the Semantic Web,
- Peer-to-peer and the Semantic Web,
- Agents and the Semantic Web,
- Semantic Web Services,
- Semantic Grid,
- Outreach to industry,
- Benchmarking and scalability,
- Design and testbed case studies.

2.6 REASE Classification

The structuring of the field proposed above is reflected by the classification of learning units in REASE. As REASE is specialized for Semantic Web, the classification does not include topics listed above as prerequisites with except of the above mentioned topics in Intelligent Systems, where courses offered in undergraduate curricula are usually not sufficient for graduate Semantic Web education. The top level of REASE classification includes thus the following areas, discussed in previous sections:

i. Knowledge Engineering / Ontology Engineering,

ii. Knowledge Representation and Reasoning,

iii. Basic Web information technologies,

iv. RDF/RDF Schema,

v. Semantic Web query and update languages,

vi. Ontologies for the Semantic Web,

vii. Semantic Web Rules + Logic,

viii. Proof in the Semantic Web,

ix. Security/trust/privacy in the Semantic Web,

x. Semantic Web Applications,

xi. Semantic Web Special Topics.

Full REASE classification is given in Appendix A, showing also covering of the structure by existing learning units.

3 Existing learning units and materials

This section discusses how the topics in the proposed structure are supported by the materials in REASE (in particular by the materials provided by REWERSE) and by the courses offered in the Erasmus Mundus supported European Master Program in Computational Logic, where some REWERSE participants play a leading role.

3.1 Learning units in REASE

REASE[2] is a repository of learning units created on the initiative of Knowledge Web supported by REWERSE as explained in the REWERSE deliverable E-D2. As explained in Knowledge Web deliverable D3.1.5, by the end of 2005 62 learning units have been published on REASE, out of which 11 are especially targeted for industrial education. For university education the REASE material of special interest are full-course materials and tutorials, especially those in English. Below we list the REASE materials satisfying these criteria. More detailed description of all REASE materials is provided by Knowledge Web deliverable D3.1.5.

3.1.1 Long courses

Index	RC1
Title	Semantic Web Lecture
Provider	L3S Research Center Hannover; REWERSE and Knowledge Web
Categories	Basic Web Information Technology, XML, Ontologies for the Semantic Web, RDF/RDFS, Ontology Engineering, Logics, Security/Privacy/Trust, Semantic Web Rules + Logics, Rule Markup, Social Networks and the Semantic Web
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lear-diederich-1095939128541 http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lear-diederich-1095948083855 http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lear-diederich-1096016131071 http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lear-diederich-1096017582439
Comment	Four modules kept separately on REASE: Overview and XML techniques, RDF,RDFS and OWL, Rules and Logics, Adaptive Hypermedia.

Index	RC2
Title	Introduction to Description Logics
Provider	Free University of Bozen-Bolzano
Categories	Logics, Knowledge Engineering / Ontology Engineering
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-free-franconi-1099402926874

[2] http://rease.semanticweb.org

Index	RC3
Title	Web-based Knowledge Representation
Provider	Vrije Universiteit Amsterdam
Categories	XML, RDF / RDFS, OWL
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-vrij-frankh-1098889115195

Index	RC4
Title	Semantic Web and Semantic Web Services
Provider	National University of Ireland, Galway
Categories	Semantic Web Applications, Semantic Web Infrastructure
URL	
	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-natia-jbreslin-1133192611850

3.1.2 Learning Modules

Index	RM1
Title	Introduction to XSL
Provider	University of Trento
Categories	Basic Web Information Technology
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-univ-ronchet-1097778439781

Index	RM2
Title	Introduction to XML
Provider	University of Trento
Categories	Basic Web Information Technology
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrIDlr-univ-ronchet-1097777977326

Index	RM3
Title	Introduction to Java tools for dealing with XML
Provider	University of Trento
Categories	Basic Web Information Technology
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-univ-ronchet-1097779082452

Index	RM4
Title	Introduction to Knowledge-Level Models of Problem Solving
Provider	The Open University, UK
Categories	Knowledge Engineering / Ontology Engineering, Methodologies
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-theo-emotta-1097763040129

Index	RM5
Title	Classification Problem Solving
Provider	The Open University, UK
Categories	Knowledge Engineering / Ontology Engineering, Methodologies
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-theo-emotta-1097764942806

Index	RM6
Title	Methods and tools for corporate memories
Provider	INRIA
Categories	Methodologies, Tools, Knowledge Management
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-inri-sylvain_d-1098114616208

Index	RM7
Title	Description Logics for Conceptual Design, Information Access, and Ontology Integration
Provider	Free University of Bozen-Bolzano
Categories	Knowledge Engineering / Ontology Engineering
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-free-franconi-1099402118641

Index	RM8
Title	Ontological Engineering
Provider	Universidad Politecnica de Madrid
Categories	Ontologies for the Semantic Web
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-univa-asun-1099404115104

Index	RM9
Title	OWL Tutorial: Introduction to Ontology Development and Protégé-OWL
Provider	The University of Manchester
Categories	Semantic Web Special Topics
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-theu-jeff-1100715238891

Index	RM10
Title	Introduction to Semantic Web Ontology Languages
Provider	Free University of Bozen-Bolzano/KW and Heraklion/REWERSE
Categories	Logics
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-free-franconi-1122522631796
Comment	REWERSE Summer School “Reasoning Web” 2005

Index	RM11
Title	Ontology mapping: a way out of the medical tower of Babel?
Provider	Vrije Universiteit Amsterdam
Categories	Mapping / Translation / Matching / Aligning (Heterogeneity), Ontology Representation / Ontology Languages / OWL
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-vrij-holger-1133369895277

Index	RM12
Title	Fundamental Research Challenges Generated by the Semantic Web
Provider	Vrije Universiteit Amsterdam
Categories	Ontologies for the Semantic Web, Knowledge Representation and Reasoning, Knowledge Engineering / Ontology Engineering, Semantic Web Applications
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-vrij-holger-1133383390634
Comment	A 1 hour video

Index	RM13
Title	OWL: An Ontology Language for the Semantic Web
Provider	The University of Manchester
Categories	Ontology Representation / Ontology Languages / OWL
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-theu-seanb-1133441337998

Index	RM14
Title	OWL Reasoning Examples
Provider	The University of Manchester
Categories	Ontology Representation / Ontology Languages / OWL
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-theu-seanb-1133441594714

Index	RM15
Title	WSMO (the Web Service Modeling Ontology) Tutorial
Provider	The Open University, DERI
Categories	Semantic Web Special Topics, Semantic Web Services
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-theo-liliana-1097851359341

Index	RM16
Title	Distributed Artificial Intelligence and Knowledge Management: ontologies and multi-agent systems for a corporate semantic web
Provider	INRIA
Categories	Ontologies for the Semantic Web, Basic Web Information Technology, Knowledge Engineering / Ontology Engineering, RDF / RDFS, Semantic Web Special Topics
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-inri-fabien_gadon-1098109372460

Index	RM17
Title	Knowledge Assisted Multimedia Analysis
Provider	CERTH
Categories	Semantic Web Special Topics, Multimedia
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrIDlr-cent-vkpapa-1098345323868

Index	RM18
Title	Document Annotation Through Information Extraction
Provider	University of Sheffield
Categories	Web Data Extraction, NLP / HLT
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-usfd-fciravegna-1099915337904
Comment	Second European Summer School on Ontological Engineering and the Semantic Web, 2004

Index	RM19
Title	Introduction to Multi-agent systems
Provider	University of Liverpool
Categories	Agents and the Semantic Web
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-univb-valentina-1099517115906

Index	RM20
Title	Text mining and the Semantic Web
Provider	University of Sheffield
Categories	NLP / HLT
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-usfd-diana-1110385153182

Index	RM21
Title	Automating Document Annotation using Human Language Technologies and Machine Learning
Provider	University of Sheffield
Categories	Web Data Extraction, NLP / HLT
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-usfd-cirave-1122455322366
Comment	Tutorial at the Third Semantic Web Summer School 2005

Index	RM22
Title	Rules and Ontologies in F-logic
Provider	State University of New York at Stony Brook / REWERSE
Categories	Ontologies for the Semantic Web, Logics, Logic Programming, Rule Languages
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-stat-kifer-1118033616456
Comment	REWERSE Summer School “Reasoning Web” 2005

Index	RM23
Title	Knowledge-base Programming with Frames and Logic
Provider	State University of New York at Stony Brook / REWERSE
Categories	Logics, Ontologies for the Semantic Web, Logic Programming
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-stat-kifer-1118035174076

Index	RM24
Title	Web and Semantic Web Query Languages: A Survey
Provider	LMU/REWERSE
Categories	RDF / RDFS, Query Languages
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lmua-bry-1118475429024
Comment	REWERSE Summer School “Reasoning Web” 2005

Index	RM25
Title	Information Extraction for the Semantic Web
Provider	DBAI, Vienna University of Technology/REWERSE
Categories	Basic Web Information Technology, Web Data Extraction, Web Data Integration
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-dbai-robert-1118694353138
Comment	REWERSE Summer School “Reasoning Web” 2005

Index	RM26
Title	Personalization for the Semantic Web -Part II-
Provider	Universita' degli Studi di Torino/REWERSE
Categories	Personalization Techniques, Semantic Web Special Topics, eLearning
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-dipd-baldoni-1119445597087
Comment	REWERSE Summer School "Reasoning Web" 2005

Index	RM27
Title	Evolution and Reactivity on the Semantic Web
Provider	F. Ciências Tecnologia, U. Nova Lisboa and University of Göttingen /REWERSE
Categories	Rule Languages, Update Languages, Logics
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-fcin-jja-1121071930599
Comment	REWERSE Summer School "Reasoning Web" 2005

Index	RM28
Title	Personalization for the Semantic Web, Part I
Provider	L3S Research Center, Hanover/REWERSE
Categories	Personalization Techniques
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lear-henze-1119511340834
Comment	REWERSE Summer School "Reasoning Web" 2005

Index	RM29
Title	Towards Types for Web Rule Language
Provider	Linköping University and PAS Warsaw/REWERSE
Categories	Rule Languages, Query Languages
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-link-wlodr-1129138244147
Comment	REWERSE Summer School "Reasoning Web" 2005

Index	RM30
Title	OWL-S for Agents
Provider	University of Southampton
Categories	Semantic Web Services, Agents and the Semantic Web
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-univi-caphreak-1118829328036
Comment	Provided by AgentLinkIII

Index	RM31
Title	Rule Modelling and Markup I
Provider	TU Cottbus (REWERSE)
Categories	Rule Markup
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lmua-stheidmann-1137658746573
Comment	REWERSE Summer School “Reasoning Web” 2005

Index	RM32
Title	Rule Modelling and Markup II
Provider	TU Cottbus (REWERSE)
Categories	Rule Markup
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lmua-stheidmann-1137659189770
Comment	REWERSE Summer School “Reasoning Web” 2005

Index	RM33
Title	Rational Agents in Logic Programming for the Semantic Web
Provider	F. Ciências Tecnologia, U. Nova Lisboa and University of Göttingen /REWERSE
Categories	Tools, Logic Programming
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-fcin-lmp-1135242087035

Index	RM34
Title	Motivation for fuzzy OWL
Provider	Vrije Universiteit Amsterdam
Categories	Ontology Representation / Ontology Languages / OWL, Reasoning
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-fcin-lmp-1135242087035

Index	RM35
Title	Web Service Modelling eXecution environment
Provider	DERI Galway
Categories	Web Services, Semantic Web Applications
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-natia-jbreslin-1135088696250

3.1.3 Learning Units for Industrial Education

Index	RI1
Title	Semantic Web Tutorial
Provider	Free University Berlin
Categories	Outreach to Industry, Knowledge Management, Semantic Web Applications
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-freea-lnixon-1130411486152

Index	RI2
Title	RDF Briefing
Provider	Vrije Universiteit Amsterdam
Categories	RDF/ RDFS, Ontology Representation, Ontology Languages/ OWL, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-vrij-holger-1133369535466

Index	RI3
Title	Semantic Web Services: A state of the art report
Provider	Vrije Universiteit Amsterdam
Categories	Semantic Web Services, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-vrij-holger-1133372701206

Index	RI4
Title	Ontology Engineering Best Practices - Building and Applying the SWRC Ontology
Provider	AIFB - University of Karlsruhe
Categories	Methodologies, Modularization and Composition, Ontology Engineering, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-lear-diederich-1134387089110

Index	RI5
Title	Human Language Technology for the Semantic Web
Provider	University of Sheffield
Categories	NLP / HLT, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-usfd-diana-1097059567085

Index	RI6
Title	Perspectives for Semantic Web Applications in Europe
Provider	Free University Berlin
Categories	Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-freea-lnixon-1118762437312

Index	RI7
Title	Practical Applications of Human Language Technologies for the Semantic Web
Provider	University of Sheffield
Categories	NLP / HLT, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-usfd-diana-1118919150028

Index	RI8
Title	HLT and Knowledge Acquisition for the Semantic Web: A Hands On Tutorial
Provider	University of Sheffield, AIFB University of Karlsruhe, Vrije Universiteit Amsterdam
Categories	NLP / HLT, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-usfd-diana-1118922707478

Index	RI9
Title	Schema and Ontology Matching
Provider	University of Trento, INRIA
Categories	Outreach to Industry, Mapping / Translation / Matching / Aligning (Heterogeneity)
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-univ-pavel-1121707366586

Index	RI10
Title	Semantic Web Use Cases
Provider	Free University Berlin
Categories	Outreach to Industry, Knowledge Management, Multimedia, eBusiness
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-freea-lnixon-1129891830518

Index	RI11
Title	The Semantic Web and the Future of Social Software
Provider	National University of Ireland, Galway
Categories	Outreach to Industry Social Impact of the Semantic Web
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-natia-jbreslin-1133201478703

Index	RI12
Title	Blogging for Business: Syndication and RSS
Provider	National University of Ireland, Galway
Categories	Basic Web Information Technology, Outreach to Industry
URL	http://rease.semanticweb.org/ubp/PUSH/srchDetailsLR?lrID=lr-natia-jbreslin-1133201478703

3.2 Semantic Web Modules in European Master Program in Computational Logic

The Erasmus Mundus supported European Master Program in Computational Logic provides (as one of the options) graduate education in Semantic Web. This section attempts to classify relevant modules and courses offered in the program according to the classification discussed in this deliverable[3]. Descriptions of the courses of the program is provided in Appendix B. The program started in the academic year 2004/05 in cooperation between

- Technische Universität Dresden, Germany (TUD),
- Universidade Nova de Lisboa, Portugal (UNL),
- Technische Universität Wien, Austria (TUV),
- Free University of Bozen-Bolzano, Italy (FUB),
- Universidad Politécnica de Madrid, Spain (UPM).

The essence of the European Master Program in Computational Logic is an integrated study program - based on common and compulsory foundation modules comprising 42 ECTS credit points, which are taught at each partner institution, selected advanced modules comprising 36 ECTS credit points, which are based on the specific strengths in research of the partner institutions, a project of 12 ECTS credit points and a research master thesis of 30 ECTS credit points. This results in a 2-year program of 120 ECTS credit points. The foundation modules are offered in the first year by all partner institutions with the common aim of bringing the students to an equivalent level of skills and knowledge. The student's specialization (advanced modules, project and master's thesis) during the second year can also be pursued with all partner institutions, but varies from place to place according to local strengths in teaching and research.

It should be noticed that

- The compulsory foundational modules comprising 42 ECTS credits include:
  - Advanced Logics (9 ECTS credit points), referred in the sequel as [EC1], Categories: ii.1 Logics,
  - Logic and Constraint Programming (12 ECTS credit points)[EC2], Categories: ii.2 Logic Programming,
  - Integrated Logic Systems (9 ECTS credit points) [EC3], Categories: ii.3 Reasoning.

  Each of the modules consists of lectures and tutorials and includes the final written examination. In this respect they can be compared with larger REASE courses.
- All participating partner institutions offer Semantic Web related advanced modules or courses. Three of them (TUD, UNL, TUW) also participate in REWERSE and the remaining two (FUB, UPM) - in Knowledge Web.

[3] In a few cases foundational courses are classified by referring to the IEEE/ACM Computer Science Curriculum CC 2001.

We now show how the advanced Semantic Web related modules offered by the participating partners can be linked to the classification of Appendix A. For this we briefly survey the modules offered by each partner. For more information see Appendix B and Web links therein.

Technische Universität Dresden offers the following Semantic Web related courses and seminars:

- Reasoning Agents course [EC8]
  Categories: ii.3 Reasoning, xi.5 Agents,
- Logic-Based Knowledge Representation course [EC9]
  Categories: ii. KR and Reasoning,
- Knowledge Representation and Reasoning for the Semantic Web seminar [ES1]
  Categories: iv. RDF/RDFS, vi. Ontologies and the Semantic Web, vii. Semantic Web Rules,
- Reasoning Agents II seminar [ES2]
  Categories: xi.5 Agents, ii. KR and Reasoning
- Knowledge Representation and Reasoning seminar [ES3]
  Categories: ii. KR and Reasoning,
- Multi Agent Systems seminar [ES4]
  Categories: xi.5 Agents,

Universidade Nova de Lisboa offers two Semantic Web related advanced modules:

The Semantic Web module consists of two courses of 6 ECTS credit points each:

- XML Technology [EC4]
  Categories: iii.1 XML,
- Reasoning in the Semantic Web [EC5]
  Categories: iv. RDF/RDFS, vi. Ontologies for the Semantic Web and vii. Semantic Web Rules+Logic,

The Knowledge, Reasoning and Agents module is comprised of 2 equal-sized courses of 6 ECTS each:

- Knowledge Representation and Reasoning course [EC6]
  Categories: ii. Knowledge Representation and Reasoning.
- Agents course [EC7]
  Categories: xi.5 Agents and Semantic Web.

Technische Universität Wien offers the following Semantic Web related courses:

- Web Data Extraction and Integration course [EC10]
  Categories: iii.1 XML, iii.2 Web data integration, iii.6 Web data extraction,
- Web Information Extraction course [ES5]
  Categories: iii. Basic Web information Technologies, vi. Ontologies and the Semantic Web,

Free University of Bozen-Bolzano offers a Semantic Web module comprising 8 ECTS credit points and Extended Semantic Web module comprising 12 ECTS credit points.

These modules provide an introduction to the ideas and technologies underlying the proposals and projects grouped under the rubric of the Semantic Web. "The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." (Tim Berners-Lee), and will investigate the series of technologies in use and under development to achieve this vision, as well as sample applications of these technologies. Topics like the World Wide Web Consortium (W3C) standards as the Extensible Markup Language (XML), the Resource Description Framework (RDF), the OWL Web Ontology Language, are examined by reading and discussing existing specifications and cutting-edge research papers.

For both modules, the students choose from the following courses:

- Semantic Web Technologies (4 credits) [ES6],
  Categories: iv. RDF/RDFS, vii. Semantic Web Rules+Logic, vi. Ontologies and the Semantic Web,
- Knowledge Bases and Databases (4 credits)[EC11],
  Categories: i. Knowledge Engineering,
- Knowledge Representation (4 credits) [EC12],
  Categories: ii. KR and Reasoning,
- XML and Semi-structured Databases (4 credits) [EC13],
  Categories: iii.1 XML, CC2001 (IM2) Information Management - Database systems,
- Internet Technologies II (4 credits)[EC14],
  Categories: CC2001 (NC) Net centric computing,
- Distributed Databases (4 credits) [EC15],
  Categories: CC2001 (IM2) Information Management - Database systems,
- Digital Libraries (4 credits)[EC16],
  Categories: CC2001 (IM) Information Management

Universidad Politécnica de Madrid offers the advanced module Web Semantics (12 ETCS) The module introduces concepts related with the Semantic Web. Different aspects linked with this idea are studied, like the use of metadata and ontologies, common standards, agents and multi-agents systems. Practical applications are discussed.

The module consists of the following courses:

- Intelligent Agents and Multi-agent Systems (6 ETCS) [EC17],
  Categories: xi.5 Agents,
- Ontologies and the Semantic Web (6 ETCS) [EC18],
  Categories: i. Knowledge Engineering/Ontology Engineering, vi. Ontologies for the Semantic Web.

4 Conclusions

4.1 Summary

We attempted to identify a body of knowledge in the field of Semantic Web, to structure it and to identify its links to Computer Science. We referred to IEEE/ACM CC2001 document for identifying prerequisites for graduate Semantic Web education.

The proposed structure is preliminary and will be subject of further discussion in REWERSE and in Knowledge Web. Also, as the Semantic Web is still a subject of active research and change, defining any curriculum recommendation will necessarily be subject of changes in close future.

Appendix A shows the areas of the proposed structure which are addressed by existing materials in REASE and/or by the Semantic Web relevant courses offered in the European Graduate Program in Computational Logic. Whether or not the existing learning units cover all the relevant aspects of the addressed field is impossible to conclude without more detailed descriptions of the topics in the structure. Development of such descriptions is a subject of future work. We notice that according to the information at hand some of the topics in the structure are not yet supported by existing learning units/learning material. In some cases this may be caused by insufficient development of the field. For example this seems to apply to some of the listed topics in the area "x. Semantic Web Applications", or to the area "vii. Semantic Web Rules" which only recently became a subject of W3C activities. Also the importance of some topics in the foundational areas "i. Knowledge Engineering/Ontology Engineering" and "iii. Basic Web information technologies" might not have been yet sufficiently explored in the context of the Semantic Web. The "proof level" postulated in the original Semantic Web vision of Tim Berners-Lee (see e.g. http://www.w3.org/2000/Talks/1206-xml2k-tbl/slide10-0.html) and reflected by the area "viii. Proof" of the Semantic Web in our structure was not yet sufficiently explained. It seems that proofs are inherent both on ontology level and rule level and there may be no need for special proof level. In any case none of the learning units discussed in this deliverable is classified in this area.

4.2 Future Work

The future work includes:

- **Refinement of the proposed structure.** The discussion preceding preparation of this deliverable will be continued, taking into account recent developments in the field, especially W3C activities, and new contributions to REASE. This may lead to revision of the proposed structure. The structure will be refined by suggesting the recommended content for the foundational topics not covered by CC2001 and for the core topics of the Semantic Web. The refined structure will be used as program guideline for future REWERSE summer schools and for defining recommendations for graduate Semantic Web education. In particular the recommendation should consider different options in graduate Semantic Web education, identifying the prerequisites and the elements of the structure to be covered by a defined option. The progress will be reported in the deliverable E-D11 Revised Higher Education Curriculum.

- **Supporting the structure by new learning units in REASE.** This applies in the first hand to the topics in our structure which are not covered by the existing units, and/or

to the topics which are closely related to REWERSE research with particular focus on recent developments. These criteria have been taken into account while preparing the programme of the REWERSE Summer School 2006 (see forthcoming deliverable E-D8-1). The materials of the school will be uploaded in REASE. Among others they will address the following topics in the structure:

- Bioinformatics and the Semantic Web,
- Semantic Web query and update languages with particular focus on recent developments,
- Rule languages for the Semantic Web with particular focus on W3C Rule Interchange Format and on integration of rules and ontologies postulated in the original vision of the Semantic Web architecture.
- Outreach to industry, not yet addressed by REWERSE will be a subject of two contributions.

REWERSE will also encourage uploading to REASE learning materials of Erasmus Mundus supported European Master Program in Computational Logic.

Acknowledgment

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Appendix A

This appendix summarizes the proposed classification, and uses it to classify learning units described in Section 3. This classification is already used in REASE. Here, in addition to REASE learning units we also attempt to classify the courses offered in the Semantic Web modules of the European Master Programme in Computational Logic. This gives a rough idea how the proposed structure is addressed/covered by educational efforts of the European Semantic Web community.

The learning units described in Section 3 are referred to in the Appendix by the indices introduced in the descriptions of Section 3. Each reference consists of two letters and a serial number, corresponding to the textual ordering of descriptions in Section 3. The meaning of the first letter is: R - unit material published in REASE, E - learning unit provided by the European Master Programme in Computational Logic. The meaning of the second letter is: C - long course; M - shorter module, S - seminar, I - material for industrial courses. The material provided/co-authored by REWERSE members is indicated by bold font. Notice that the same unit index may appear many items, if the unit addresses different topics of the classification.

REASE Classification and its coverage

i. Knowledge Engineering / Ontology Engineering **RC1**, RC2, RM7, RM8, RM12, RM16, RI4, EC11

   1. Methodologies RM4, RM5, RM6, RI4
   2. Ontology population / generation
   3. Maintenance and versioning (dynamics)
   4. Mapping / translation / matching / aligning RM11, RI9
   5. Validation
   6. Interoperability / Integration
   7. Modularization and Composition RI4
   8. Tools RM6, RM33

ii. Knowledge Representation and Reasoning RM12, **EC6**, EC9, ES2, ES3, EC12

   1. Logics **RC1**, RC2, **EC6**, EC9 **RM10**, **RM22**, **RM23**, **RM27**, **EC1**,
   2. Logic Programming **RM22**, **RM23**, **RM33**, **EC2**, **EC6**
   3. Reasoning RM34, **EC3**, **EC6**, EC8

iii. Basic Web information technologies **RC1**, RM16, **RM25**, RI12, **ES5**

   1. XML **RC1**, RC3, RM1, RM2, RM3, **EC4**, **EC10**, EC13
   2. Web data integration **RM25**, **EC10**
   3. Security
   4. Web services RM35
   5. Personalization techniques **RM26**, **RM28**
   6. Web data extraction RM18, RM21, **RM25**, **EC10**
   7. Architecture of Web Information Systems

iv. Resource Description Framework / RDFSchema **RC1**, RC3, RM16, **RM24**, RI1, ES1, ES6

v. Semantic Web Query and Update Languages

   1. Query Languages **RM24**, **RM29**
   2. Update Languages **RM27**

vi. Ontologies for the Semantic Web **RC1**, RM8, RM12, RM16, **RM22**, **RM23**, **EC5**, ES1, **ES5**, ES6, EC18

1. Ontology representation / Ontology languages / OWL RC3, RM9, RM11, RM13, RM14, RM34, RI1, **EC5**
2. Ontology Engineering **RC1**, RM16
3. Ontology reasoners

vii. Semantic Web Rules + Logic **RC1**, **EC5**, ES1, ES6

1. Rule languages **RM22**, **RM27**, **RM29**
2. Rule Markup **RC1**, **RM31, RM32**, **EC5**, ES6
3. Reasoning languages **EC5**
4. Rule reasoners

viii. Proof in the Semantic Web

ix. Security / trust / privacy in the Semantic Web **RC1**

x. Semantic Web Applications RC4, RM12, RM35, RI1

1. Knowledge Management RM6, RI1, RI10
2. e-learning **RM26**
3. Bioinformatics
4. Multimedia RM17, RI10
5. e-health
6. e-business RI10
7. Law
8. Engineering
9. e-government

xi. Semantic Web Special Topics **RC1**, RM9, RM15, RM16, RM17, **RM26**

1. Natural language processing / human language technologies RM18, RM20, RM21, RI5, RI7, RI8,
2. Social impact of the Semantic Web RI11
3. Social networks and Semantic Web **RC1**
4. Peer-to-peer and Semantic Web
5. Agents and Semantic Web RM19, RM30, **EC7**, EC8, ES2, ES4, EC17
6. Semantic Grid
7. Semantic Web Services RC4, RM15, RM30, RI3
8. Outreach to industry RI1, RI2, RI3, RI4, RI5, RI6, RI7, RI8, RI9, RI10, RI11, RI12
9. Benchmarking and scalability
10. Design and testbed case studies

Appendix B

This Appendix provides a more detailed information about Semantic Web related courses offered by each of the universities participating in the Erasmus Mundus supported European Master Program in Computational Logic. The information includes links to the home pages of the offered courses. The intention for providing this documentation is to use it in further work of the Education and Training Work Package of REWERSE as a reference while developing graduate Semantic Web curricula recommendations.

International M.Sc. Program in Computational Logic at TUD, Dresden

http://www.computational-logic.org/content/study/master/current.php?id=43

Semantic Web related courses at TUD

Knowledge Representation and Reasoning for the Semantic Web seminar

Lecturer: Pascal Hitzler (http://www.aifb.uni-karlsruhe.de/WBS/phi/)

Winter Term 2005/2006

Course description:

In this seminar, we will study basic and advanced means for semantic web knowledge representation and reasoning, including e.g. RDF(S), OWL and various proposed extensions of it, e.g. by uncertainty, commonsense, or paraconsistent reasoning techniques, rule-based languages and language extensions, available reasoning systems, their background theories, and means to achieve scalability.

Additional information:

the course web page: http://www.aifb.uni-karlsruhe.de/WBS/phi/teaching/ws05/

Scheduled topics

Topic and references	Speaker
Semantic Web Rules Language (SWRL) • SWRL W3C-Submission. • B. Motik, U. Sattler, R. Studer. **Query Answering for OWL-DL with Rules**, Proceedings of the 3rd International Semantic Web Conference (ISWC 2004), Hiroshima, Japan, November, 2004.	Valentin Mayer-Eichberger
KAON2 Algorithms (non-tableau reasoning with description logics) • U. Hustadt, B. Motik, U. Sattler. **Reasoning in Description Logics with a Concrete Domain in the Framework of Resolution.** Proceedings of the 16th European Conference on Artificial Intelligence (ECAI 2004), August, 2004, Valencia, Spain, pages 353–357	Christelle Braun

Topic and references	Speaker
• U. Hustadt, B. Motik, U. Sattler. **Reducing SHIQ Descrption Logic to Disjunctive Datalog Programs.** Proceedings of the 9th International Conference on Knowledge Representation and Reasoning (KR2004), June 2004, Whistler, Canada, pages 152–162	
Paraconsistency for Description Logics (Diploma Thesis)	Andreas Lang
Fuzzy Ontologies • U. Straccia. **Towards a Fuzzy Description Logic for the Semantic Web** (Preliminary Report). In Proceedings of the 2nd European Semantic Web Conference (ESWC-05), 2005. • U. Straccia. **Transforming Fuzzy Description Logics into Classical Description Logics.** In Proceeedings of the 9th European Conference on Logics in Artificial Intelligence (JELIA-04), 2004.	Dung Dinh-Khac

More topics, depending on student interest:

These topics focus on ontology languages that have emerged from research on the Semantic Web and related technologies. These languages usually provide a formal (often logical) semantics, and both their theoretical power and their practical implementation are are of great importance. Many of the topics relate to recent developments and extensions within the area and are of high interest to current research.

Topic and references	Speaker
Approximate reasoning with ontologies • P. Hitzler, D. Vrandecic. **Resolution-Based Approximate Reasoning for OWL DL.** In Proceedings of the 4th International Semantic Web Conference, Galway, Ireland, November 2005. November 2005. To appear. • P. Groot, H. Stuckenschmidt, H. Wache. **Approximating Description Logic Classification for Semantic Web Reasoning.** In Proceedings of the European Semantic Web Conference (ESWC 2005): 318–332.	
Probabilistic ontologies • D. Koller, A.Y. Levy, and A. Pfeffer. **P-classic: A tractable probablistic description logic.** In Proceedings of the AAAI 14th National Conference on Artificial Intelligence, 390–397, 1997. • Z. Ding and Y. Peng. **A probabilistic extension to ontology language OWL.** In Proceedings of the 37th Hawaii International Conference on System Sciences (HICSS), 2004. • R. Giugno and T. Lukasiewicz. **P-shoq(d): A probabilistic extension of shoq(d) for**	

Topic and references	Speaker
probabilistic ontologies in the Semantic Web. In JELIA '02: Proceedings of the European Conference on Logics in Artificial Intelligence, 86–97. Springer-Verlag, 2002. • J. Davies, A. Duke, and Y. Sure. **Ontoshare – a knowledge management environment for virtual communities of practice.** In Proceedings of the 2nd International Conference on Knowledge Capture (K-CAP2003), 23-26 October 2003, Florida, USA, 20–27. ACM Press, 2003. • M. Holi and E. Hyvönen. **Modeling Degrees of Overlap in Semantic Web Ontologies.** Submitted, 2005.	
Fuzzy Ontologies • U. Straccia. **Towards a Fuzzy Description Logic for the Semantic Web** (Preliminary Report). In Proceedings of the 2nd European Semantic Web Conference (ESWC-05), 2005. • U. Straccia. **Transforming Fuzzy Description Logics into Classical Description Logics.** In Proceeedings of the 9th European Conference on Logics in Artificial Intelligence (JELIA-04), 2004.	
Web Rule Language (WRL) • WRL: www.wsmo.org/wsml/wrl/	
Implementing OWL DL with Nominals • I. Horrocks, U. Sattler. **A Tableaux Decision Procedure for SHOIQ.** In Proceedings of Nineteenth International Joint Conference on Artificial Intelligence, IJCAI-05, 2005.	
OWL und Answer Set Programming • Th. Eiter, Th. Lukasiewicz, R. Schindlauer, H. Tompits. **Combining Answer Set Programming with Description Logics for the Semantic Web.** Proceedings of the 9th International Conference on Principles of Knowledge Representation and Reasoning (KR 2004), June 2–5, Whistler, British Columbia, Canada, 2004, pages 141–151	
Autoepistemic Extensions of OWL • R. Rosati. **Autoepistemic Description Logics.** AI Communications, volume 11(3–4), pages 219–221, 1998.	

Reasoning Agents II seminar

Lecturer: Michael Thielscher

(http://www.computational-logic.org/content/study/master/staff/thielscher.php?id=43)

Winter Term 2005/2006

Course description:

Each student chooses one of the available topics to work on. During the seminar, the student has to understand the relevant literature and writes a paper about the chosen topic (about 10 pages). The produced paper is required to conform to the standards of scientific writing. Finally, each student presents his/her work in a talk to the other participants of the seminar. Topics of this seminar are:

- Agent Programming in GOLOG (acronym for: Algol in Logic)
- Programming in CCALC (acronym for: Causal Calculator)
- Programming with the Event Calculus
- Agents for the Semantic WWW
- Multiagent Systems
- Belief Revision
- The Ramification Problem
- The Qualification Problem
- Planning

More topics will be available if needed.

Additional information: the course web page:

http://www.computational-logic.org/iccl/master/lectures/winter05/ra/ra2.html

Knowledge Representation and Reasoning seminar

Lecturer: Steffen Hölldobler

(http://www.computational-logic.org/content/study/master/staff/hoelldobler.php?id=43)

Winter Term 2005/2006

Course Description

In these weekly seminars, we will discuss papers, approaches, techniques and methods relevant for the Ph.D-, master-, and other projects which are currently worked on within the Knowledge Representation and Reasoning group. The goal of this seminar is to serve as an open discussion platform, where students can learn about other areas in KRR and get feedback on their own research.

Additional information: the course web page:

http://www.computational-logic.org/~ozan/KRS2005.html

Abstracts of just the SW related talks included the course:

Transforming Fuzzy Description Logics into Classical Description Logics - *Wu Yining*

Description Logics are limited to dealing with the problem which is either an individual is an instance of a concept or not. But in real world, the answers of this kind of questions are not only *yes* or *no*. In this project we consider Description Logics with a well-known fuzzy extension to deal with vague information. The topic is to present a reasoning preserving transformation of fuzzy DLs into classical DLs. I will take a quick look to DLs and fuzzy DLs, and then introduce the transformation.

Four Valued Logic for Paraconsistent Reasoning - *Andreas Lang*

The Semantic Web was rooted in the desire to enable machines to reason about Web content. This includes reasoning about data from different sources. Often information from different sources bear contradictions. A drawback of many logics in reasoning on contradictory data is the principle of explosion, stating that everything follows from a contradiction. This talk addresses the development of a paraconsistent (four-valued) logic that overcomes this drawback. It is shown how paraconsistent reasoning is obtained by applying standard reasoning systems for classical logic.

Special interest is devoted to the meaning of equality in a four-valued first-order logic. The definition and applicability of an equality relation is moot for discussion.

Reasoning Agents course

Lecturer: Prof. Thielscher

(http://www.computational-logic.org/content/study/master/staff/thielscher.php?id=43)

Summer Term 2005/2006

Course description:

The creation of artifacts that act autonomously and sensibly is the most exciting goal of Artificial Intelligence research. This lecture is concerned with the reasoning side of intelligent agents. The course has two main components:

- A formalism for setting up models of dynamic worlds along with a formal theory for reasoning about actions on the basis of these models.
- A programming method and system for creating agents which control their behaviour on the basis of an explicit representation of their environment.

As theory and system unfold, our agents will become capable of dealing with incomplete world models, which require them to act cautiously under uncertainty; they will be able to explore unknown environments by logically reasoning about sensor inputs; they will plan ahead some of their actions and react sensibly to action failure. The programming system allows building efficient agent programs that are easy to write, understand, and maintain. The only prerequisite for this course is some basic prior knowledge of discrete mathematics and in particular first-order logic. Some experience with programming in Prolog might also be helpful.

Additional information: the course web page:

http://www.computational-logic.org/iccl/master/lectures/summer05/ra/ra2005.html

Logic-Based Knowledge Representation course

Lecturer: Franz Baader

(http://www.computational-logic.org/content/study/master/staff/baader.php?id=43)

Summer Term 2005/2006

Course description:

Starting from a short description of early knowledge representation formalisms (such as Semantic Networks and Frames) and their shortcomings, the course will illustrate how results and methods from logic can support the design of knowledge representation systems that have high expressive power and sound and complete reasoning algorithms. In particular, we will consider Description Logics, Modal Logics, and Nonmonotonic Logics as formalisms for respectively representing terminological knowledge, subjective and time dependent knowledge, and uncertain and incomplete knowledge.

Additional information: the course web page:

http://lat.inf.tu-dresden.de/teaching/ss2005/lbkr

Multi Agent Systems seminar

Lecturer: Prof. Thielscher

(http://www.computational-logic.org/content/study/master/staff/thielscher.php?id=43)

Summer Term 2005/2006

Course description: Seminar about Multi Agent Systems

Additional information: the course web page:
http://www.computational-logic.org/iccl/master/lectures/summer05/mas/mas.html

International M.Sc. Program in Computational Logic at UNL, Lisbon

http://ssdi.di.fct.unl.pt/masters/mcl/

Semantic Web related advanced modules at UNL

Semantic Web module

Lecturers:

Carlos Damásio, http://www.centria.fct.unl.pt/~cd/,

João Moura Pires, http://www.centria.fct.unl.pt/~jmp/

This module covers both theoretical, technological and practical aspects of the development of Web-aware advanced information systems, in particular for the Semantic Web. The module is comprised of 2 courses of 6 ECTS each during two semesters, one covering XML technology and the other addressing Knowledge Representation for the Semantic Web.

- Course: **XML Technology** (http://ssdi.di.fct.unl.pt/mcl/xmlt/)
  - Semester: Winter
  - Lecturer: João Moura Pires

The first part of the module describes XML based technology fo representing hierarchical and semi-structured data, and related W3Crecommendations: XML Schemas, XML Namespaces, and XML Base. The text-centered and data-centered documents views are discussed and compared. XML data model integrity supporting mechanisms are analyzed, namely XLink, XPointer and XML Inclusions. Querying and transformation languages for XML documents are described and deeply studied, in particular XSL based-languages (XPath and XSLT) and the more recent XQuery. The course continues by relating the database relational model (DBMSs) with the hierarchical model (XML), and studying the mappings between them. The course continues by presenting client-server architectures integrating XML and relational databases, as well as XML support in the major DBMSs. The course concludes with DOM and SAX programming techniques, and construction of Web Services using SOAP.

- Course: **Reasoning in the Semantic Web**
  - Semester: Summer
  - Lecturer: Carlos Damásio

The second course, starts by explaining and motivating the origins of the Semantic Web and its logical layered structure. Some basic concepts are overviewed, namely UNICODE, URIs and IRIs, XML Base, XML Namespaces, XSL, and XML

Canonicalization. The Resource Description Framework (RDF) and RDF Schema languages are introduced for describing resources and basic vocabularies in the Semantic Web. RDF(S) model theory and inference mechanisms are also addressed, as well as practical applications and its limitations. Description Logics are then introduced as a better knowledge representation formalism. Its constructs and semantics are introduced, as well the basic reasoning tasks and corresponding algorithms. The OWL language is presented and applications are provided. The course finishes, by studying the existing proposals for the integration of ontologies with rules in the Semantic Web, in particular the RuleML language proposal is discussed.

Knowledge, Reasoning, and Agents module

Lecturers:

Luís Moniz Pereira, http://www.centria.fct.unl.pt/~lmp/

João Alexandre Leite, http://www.centria.fct.unl.pt/~jleite/

This 12 ECTS advanced module is comprised of 2 equal-sized courses of 6 ECTS each:

- Course: **Knowledge Representation and Reasoning** (http://ssdi.di.fct.unl.pt/mei/rcr/)
  - Semester: Winter
  - Lecturer: Luís Moniz Pereira

Non-monotonic computational logic formalisms for declarative knowledge representation, including default logic, circumscription, and logic programming. Temporal knowledge and action representation, including situation and event calculus. Methodologies for representing knowledge with them. Computational logic forms of reasoning and their combination, including hypothetical, abductive, paraconsistent, belief revision, argumentative, counterfactual, debugging, updating, and preferring. Logic programming based semantics, procedures, and implementations. Illustrative applications. Implemented systems and tools.

- Course: **Agents** (http://ssdi.di.fct.unl.pt/mcl/agents/index.htm)
  - Semester: Winter
  - Lecturer: João Alexandre Leite

Computational logic paradigms and formalisms for expressing agents and agent societies, with emphasis on a Logic Programming approach. Agent and agent society architecture and evolution. Combining rationality and reactivity. Centralized and distributed control. Communication and cooperation among agents. Illustrative applications. Implemented systems and tools.

European Masters Program in Computational Logic
at TUW, Vienna

http://www.logic.at/compulog/

Semantic Web related courses at TUW

Web Data Extraction and Integration course

Lecturer: Robert Baumgartner

Winter term 2005/06

Short Description: Approaches to web data extraction and integration

Keywords: XML Family, XML Schema, XPath, XSLT, XQuery, (HTML) data extraction and wrapper generation, definition and areas in IE, differentation to IR, Lixto project: Visual Wrapper and Transformation Server, application generation with Lixto, other wrapper generation languages and -tools, wrapper learning und automatic data extraction, data aggregation and syndication, portal integration, e-biz Frameworks, pdf data extraction

Fields of Study: This VU is a compulsory course or compulsory elective in some bachelor and master studies and can furthermore be selected as part of KfK Semantic Web Advanced Topics and is part of the European Master Programs Computational Logic.

Course page : http://www.dbai.tuwien.ac.at/staff/baumgart/exin0506/index_en.html

Web Information Extraction course

Lecturer: Wolfgang Gatterbauer

Winter semester 2005/06

Goal: The goal of this course is to prepare students for scientific work in the domain of Web Information Extraction. The course will focus on providing students with opportunities to demonstrate critical thinking, i.e. the ability to question existing results and to put things into perspective.

Subject: Web Information Extraction (WIE) is the process of extracting relevant information from Web pages and transforming the extracted content into a form suitable for computerized data-processing applications. For example, one application of WIE would be to locate individual products and their attributes within online product catalogues and to provide these data in a structured format such as XML or a relational database.

In order to solve this complex task, the research community is continuously working on combining and advancing a number of techniques from research areas such as artificial intelligence, information retrieval, natural language processing, wrapper learning, ontology modelling, supervised and unsupervised machine learning, statistics and data mining.

The course introduces students to current research through individual reading, analysis and comparison of selected publications. Students will present their insights in class and will engage in a collective discussion of the specific topics addressed.

Course page: http://education.dbai.tuwien.ac.at/wie/WS05/

International M.Sc. Program in
Computational Logic
at FUB, Bolzano

http://www.inf.unibz.it/mcs/emcl/modules.php

Semantic Web related advanced modules at FUB

Semantic Web modules

Keywords: www, internet, database management, ontologies, information systems, information retrieval, artificial intelligence

This module provides an introduction to the ideas and technologies underlying the proposals and projects grouped under the rubric of the Semantic Web. "The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." (Tim Berners-Lee), and will investigate the series of technologies in use and under development to achieve this vision, as well as sample applications of these technologies. Topics like the World Wide Web Consortium (W3C) standards as the Extensible Markup Language (XML), the Resource Description Framework (RDF), the OWL Web Ontology Language, are examined by reading and discussing existing specifications and cutting-edge research papers.

Semantic Web module (8 credits total)
Extended Semantic Web module (12 credits total)

For both modules, choose from the following courses:

Semantic Web Technologies (4 credits)
Knowledge Bases and Databases (4 credits)
Knowledge Representation (4 credits)
XML and Semi-structured Databases (4 credits)
Internet Technologies II (4 credits)
Distributed Databases (4 credits)
Digital Libraries (4 credits)

International M.Sc. Program in
Computational Logic
at UPM, Madrid

http://www.clip.dia.fi.upm.es/mastercl/doble_en.html

Semantic Web related advanced modules at UPM

Web Semantics (12 ETCS)

Keywords: semantics web, ontologies, agent technology, multi-agents systems.

The module introduces concepts related with the Semantic Web. The Semantic Web is a vision of the next generation Internet as intelligently linked, agent-driven, structured collections of machine-readable information through the use of metadata and software tools.
Different aspects linked with this idea are discussed, like the use of metadata and ontologies, common standards, agents and multi-agents systems. Practical applications are discussed.

Courses:

- Intelligent Agents and Multi-agent Systems (6 ETCS – 1st Semester)
- Ontologies and the Semantic Web (6 ETCS - 1st Semester)